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Argument Patterns in Redox Reaction and Electrochemistry Topics in a High School Textbook

Nathasya Imanuella*, I Wayan Redhana

Chemistry Education Study Program, Universitas Pendidikan Ganesha, Indonesia

ORCID
Nathasya Imanuella: https://orcid.org/0000-0002-1953-5457

Abstract.
Presenting teaching material in an argumentative manner makes it easier for students to understand it. This study aimed to describe and explain Toulmin's argument patterns, their percentages, the quality of arguments, and incorrect arguments in the redox reactions and electrochemistry topic in one high school chemistry textbook. The research method was document analysis. Validity was tested by triangulation among three researchers. The results showed that the patterns of Toulmin's arguments of two, three, and four elements were 51%, 34%, and 6%, respectively. The two-element argument patterns consisted of CG and GC. The three-element argument patterns comprised CGW, GWC, CWG, WCG, and GCW. The four-element argument patterns comprised GCWB, CGWB, GWCB, and CGWR. The quality of the arguments according to the parameters of the Toulmin Argumentation Protocols (TAP) varied from medium to high. In contrast, the quality based on the Quality of Argument Structure Rubric (QASR) parameters varied from fair to excellent. There were five claims, eight grounds, and two warrants that were not precise or incomplete. Most of the arguments were well written, but there were many shortcomings in providing explanations. This topic needs to be supplemented with more elements of arguments.

Keywords: argument patterns, redox reactions, electrochemistry, textbook

Corresponding Author: Nathasya Imanuella; email: nathasya@undiksha.ac.id

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1. INTRODUCTION

According to the Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 20 of 2016, one of the skills required of primary and secondary school graduates is the ability to think critically [1]. In addition, critical thinking skills are also mandated in "21st century skills." The 21st century skills can improve the quality of learning and students' participation, develop the ability to work together, and encourage learning to lead to student-centered learning [2]. Critical thinking skills are an important skill to have in everyday life, such as reasoning, requiring understanding, interpreting, analysing, and evaluating information. The process of critical thinking skills is able to make a decision based on valid and reliable conclusions, as well as adapt to changes in

the situation [3]. Some researchers define critical thinking skills as the process of thinking by using one's knowledge and experience to the fullest extent possible. Critical thinking enables students to explain a problem, examine the interconnection of problems with several factors, analyze problems, make conclusions, and solve problems [4, 5].

Therefore, critical thinking skills need to be trained in everyday learning in school. However, the critical thinking skills of students in Indonesia are still relatively low based on the previous studies [2, 6–8]. Furthermore, based on the results of the Program of International Student Assessment (PISA), Indonesian students are at level 3 out of 6 levels, which is the level where students are only able to explain simple context based on their scientific knowledge. In addition, The Trends of the International Mathematics and Science Study (TIMSS) conducted by the International Association for the Evaluation of Educational Achievement (IEA) in 2011 showed that Indonesian students have a score of 397, below the average of 500. In chemistry learning, students still experience many problems such as being unable to explain chemical phenomena [9, 10] and misconceptions [11, 12]. This proves that students' scientific knowledge is still limited when given explicit and clear evidence and has not been able to form an explanation based on existing evidence and arguments [13]. Various efforts have been made to improve students' conceptual understanding and critical thinking skills. A multiple representation-based chemistry teaching book has been developed to improve students' learning outcomes [14] and critical thinking skills [15]. Meanwhile, a case study-based chemistry teaching book was developed to improve students' learning outcomes [16] and critical thinking skills [17]. On the other hand, a green chemistry teaching book was developed to improve students' learning outcomes [18–20].

The way to improve critical thinking skills is to argue [21, 22]. In its simplest definition, an argument consists of a claim justified by the presence of evidence, and an argument refers to the process of making an argument [23]. Arguments arise when there are individuals who differ and reinforce each other's opinions with various pieces of evidence [24]. There are several advantages of having the ability to argue, such as the ease of understanding the concept because students are able to find the concept independently, the ease of students solving problems with existing stages and connecting concepts, facts, and methods of problem solving. In addition, students are also easier to communicate their ideas because they have supporting evidence [25]. Because students easily understand various concepts, argumentation is suitable to be applied in science learning and is proven to be able to improve students' learning achievement [26–28]. One of the science lessons is chemistry, so chemistry also requires argumentation in its learning. Books used by students can affect students'

critical thinking skills [29, 30]. These books are claimed to have good and systematic supporting evidence that are written in a directed and orderly way. Science textbooks, such as chemistry books, require argumentation because chemistry itself is a science that studies natural phenomena. Books that are based on argumentation or critical thinking skills are believed to be able to improve students' critical thinking skills. Aufa et al. [31] revealed that modules with the PBL model can improve the critical thinking skills of students. Additionally, Sudiana and Redhana [32] also reported that an argument-based junior high school science book is proven to improve students' critical thinking skills.

Bentahar et al. [33] introduced four argument framework models, namely the Toulmin's model, the Reed and Walton's models, the Anscombre and Ducrot's models, and the Breton's model. However, the most widely used model in educational research is the Toulmin's model. Toulmin's argument model is a model used to identify and organize an argument [23, 34]. The core of the Toulmin's argument model includes a conclusion (claim), one or more data thet support the conclusion (ground), and an explanation that connects the data with the conclusion (warrant). In some cases, backing is required to support the warrant. Qualifiers are also included to limit the conclusion of the argument. A rebuttal identifies the shortcomings of an argument [35, 36]. The Toulmin's argument model allows students or educators to analyze an argument. It is often used to analyze arguments in science learning [37–40].

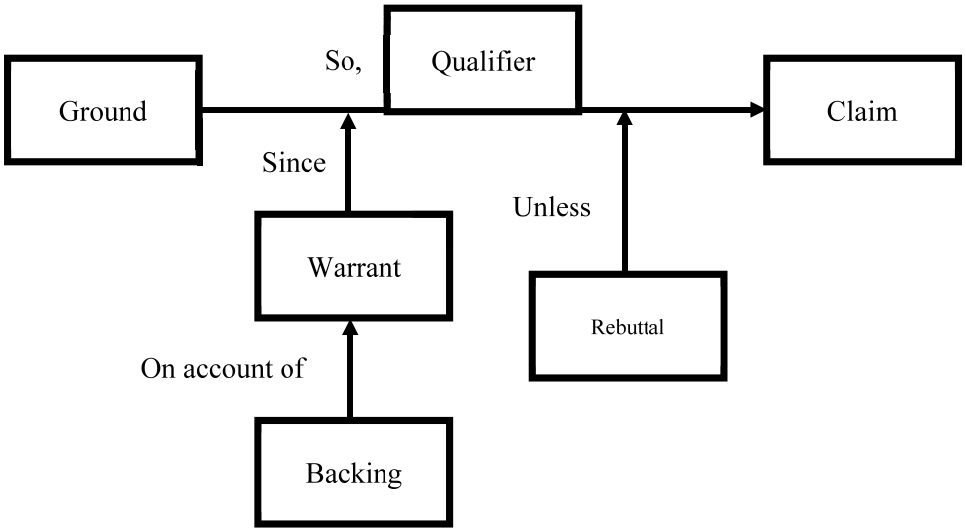

Figure 1: Toulmin's argument model.

The presentation of the most widely found arguments is in teaching books. A number of teaching books were developed by several researchers to improve learning outcomes

[14, 17] and critical thinking skills [41–43]. Based on this, the analysis of arguments in science textbooks needs to be done, especially using the Toulmin's argument model. Research on the analysis of Toulmin's arguments in science textbooks is still a bit done, specifically chemistry textbooks. The textbook analyzed is one of the chemistry textbooks for XII grade high school which is most widely used in Bali Province, Indonesia.

2. RESEARCH METHOD

This research approach was a qualitative approach with document study methods. The data collected were all sentences in the redox reactions and electrochemistry topic, which were then analyzed with Miles and Huberman's model. Every sentence in the book, except the Exercise section, Problem Examples, Examples, Activities, Chemical Info, Competency Tests, and Summaries, was analyzed to obtain Toulmin's argument patterns, the quality of the argument elements, and fallacious arguments. The validity of the data was determined by triangulating among researchers. The study involved three researchers consisting of a student researcher and two high school teacher researchers who conducted an analysis based on Toulmin's argument. Differences in the results of the analysis were discussed among researchers to obtain more accurate results. The elements of Toulmin's argument can be determined based on their respective roles according to the definition in Table 1.

TABLE 1: Definition of every element of Toulmin's argument [33, 35, 44].

Element	Definition
Claim (C)	Statements or conclusions are presented to the reader and which are potentially controversial (may not meet the reader's initial beliefs).
Ground (G)	Statements that support previously established facts or beliefs related to a situation in which the claim was made.
Warrant (W)	Statement, which justifies the claim from the ground.
Backing (B)	A collection of information, which guarantees the correctness of the warrant. A backing is required if the warrant is challenged. Backing is the underlying data of reason.
Qualifier (Q)	A statement that revealed the level of certainty associated with the claim.
Rebuttal (R)	A statement presenting a situation in which the claim could be attenuated.

To identify the quality of the Toulmin argument element, two parameters can be used, namely TAP Toulmin Argumentation Protocols (TAP) and Quality of Argument Structure Rubric (QASR). The explanation of each parameter is presented in Table 2 and Table 3.

In addition to analysing the pattern of Toulmin's argument as well as the quality of each element of arguments, the thing that needs to be analyzed is the wrong

Table 2: Indicators of the quality of Toulmin's argument elements using the TAP parameters [45].

Element	Level	Indicator
Claim (C)	High	Statements are based on facts
	Medium	Statements are based on the author's attitude, such as good and bad, right and wrong, or better and worse.
	Low	Statements are based on the author's personal opinion.
Ground (G)	High	Statements are based on research results, observations, or statistical data.
	Medium	Statements are based on concepts that support claim.
	Low	Statements are based on personal opinion without empirical concepts or facts.
Warrant (W), Backing (B), Qualifier (Q)	High	Statements are based on the expert's view of the claims expressed.
	Medium	Statements are based on scientific understanding, e.g. general rules and applicable principles.
	Low	The statements are based on the author's view of his daily life.
Rebuttal (R)	High	Statements are based on conceptual evidence or empirical evidence, as well as reasoning.
	Medium	Statements are based on conceptual evidence accompanied by the author's personal opinion.
	Low	The statements are based on the author's personal opinion completely.

or incomplete arguments. Arguments are considered false or erroneous if there are irrelevant grounds or warrants to support the claim, or if the claim is incomplete and inappropriate. There are five types of fallacies in arguments, e. g. fallacies of vagueness, fallacies of ambiguity, fallacies of relevance, fallacies of vacuity, and refutation. Of the five types of fallacies, the most standard relevance and ambiguity fallacies exist in the arguments. Fallacies of relevance occur when the contents of the ground/warrant are not logically relevant to the claim [47]. Meanwhile, fallacies of ambiguity occur if the sentences on the claim/ground/warrant can mean double or less clear meaning [48].

3. RESULTS AND DISCUSSION

There were 41 discourses in the redox reaction and electrochemistry topic, with each discourse having one argument so that there are as many as 41 arguments. The number of argument sentences was 207 sentences, while the number of non-argument sentences was 25 sentences. The number of argument sentences far exceeded the number of non-argument sentences, so most of the contents of this topic already formed a good argument. Of the 41 arguments, there was only a pattern of Toulmin's

Table 3: Indicators of the quality of Toulmin's argument elements using the QASR parameters [46].

Parameters				
Element	**Poor**	**Fair**	**Good**	**Excellent**
Claim (C)	Claim doesn't exist.	Claim needs to be added and less clear.	Claims are clear but something has to be added.	Claim is clear and easily identifiable.
Warrant (W)	Warrant is not identified and does not link claims and ground.	Warrant slightly connects claim and ground, and is less clear.	Warrant is clear but something has to be added	Warrant connects claims and ground, written clearly and easily identifiable.
Backing (B)	Backing was not identified.	Backing reinforces the warrant, but its relationship with the warrant is less clear.	Backing strengthens the warrant, but something has to be added.	Backing strengthens warrant
Ground (G)	Ground does not exist or ground exists but is irrelevant to the claim.	Ground needs to be added and less clear.	The ground is clearly written but there is something to add.	Ground is clearly written and easily identifiable.
Qualifier (Q)	Qualifying is unsatisfactory.	Qualifier seeks to limit claims.	Qualifier partially limits claims	Qualifiers completely limit claims.
Rebuttal (R)	Rebuttal does not exist.	Rebuttal needs to be added and less clear.	Rebuttal is clearly written but something has to be added.	Rebuttal is clear, easily identifiable, and relevant to the claim.

arguments of two elements, three elements, and four elements. The Toulmin's two-element argument patterns were the patterns that dominated this topic, while the Toulmin's four-element argument patterns were the least (Figure 2). There was no pattern of arguments using a single element. This is because one element, the claim, is not strengthened by another element, so it cannot be called an argument. In addition, there was no pattern in Toulmin's arguments for five elements and six elements. Previous researchers also reported that Toulmin's argument patterns with complete or almost complete elements were rare in writing [49–51]**.** Judging from the existence of the argument element, only the qualifier element was not present in the redox reaction and electrochemistry topic.

In the redox and electrochemistry topic, the two-element Toulmin's argument was the most dominating pattern, consisting of claim and ground. This indicates that most of the discourses in this topic still form arguments by including only one element to

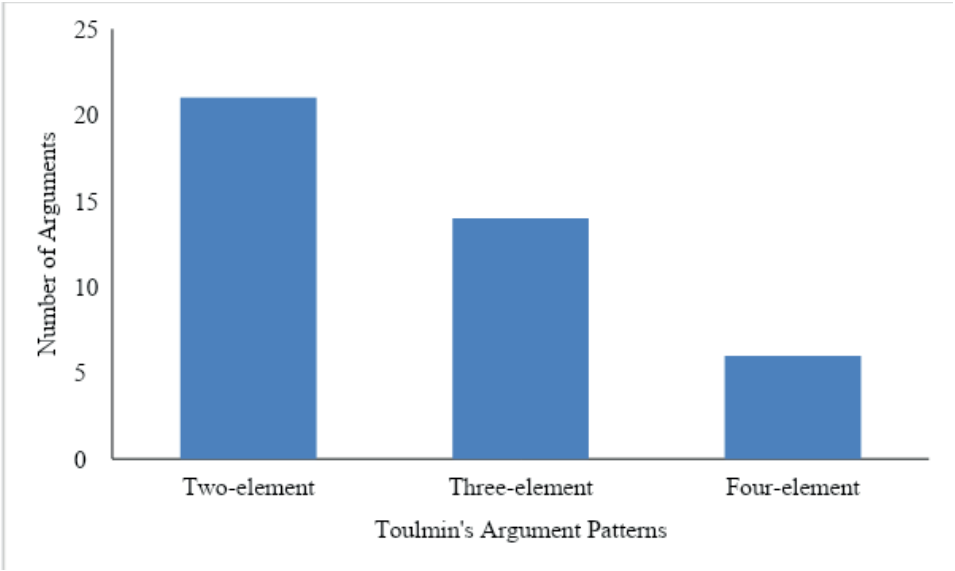

Figure 2: Number of Toulmin's arguments.

support the claim. Such a pattern belongs to the basic argument pattern, which does not include warrants or supporting elements. There were only two variations of the two-element Toulmin's argument, namely CG and GC. The CG pattern was more than the GC pattern. This indicated that the author of the book was more likely to explain the claim, then provided data or evidence to strengthen the claim, rather than the claim being explained after the data was submitted. The Toulmin's argument pattern consisted of two elements, one of which was the 6th discourse (Figure 3). In the 6th discourse, there was an explanation of the function of the salt bridge and how the mechanism of the salt bridge works in Voltaic cells. The claim contained information about the function of the salt bridge in general, and the ground contained information about the salt bridge process to neutralize excess electrical charge in Voltaic cells. Each element in the Toulmin's model did not have to be delivered in a single sentence and can be delivered in multiple sentences depending on the function of those sentences in support of the claim. The ground in this chapter was found in the form of concepts underlying claims, chemical reactions, problem-solving measures, chemical processes that occur, observational results, and experimental data.

In addition, the Toulmin's three-element argument pattern contained as many as five variations of the patterns, such as CGW, GWC, CWG, WCG, and GCW. Variations of these patterns involved only three elements, with additional warrants having no additional supporting elements. The GWC pattern has the most compared to the patterns of the other three elements, which meant as many as seven arguments. This is because the warrant is a connecting element between the claim and the ground, so its position is

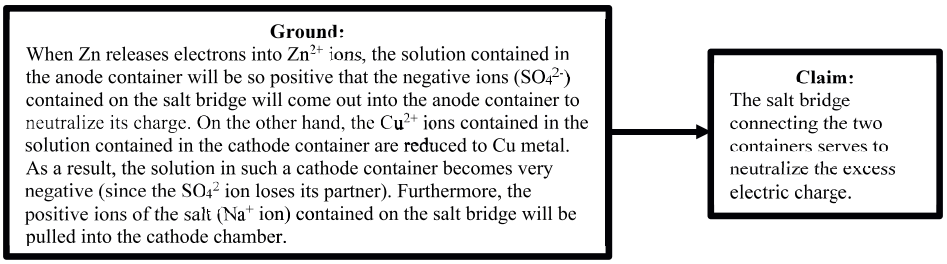

Figure 3: The 6th discourse on the role of salt bridges in Voltaic cells.

between the claim and the ground. However, the warrant position can also be found not in the middle of the claim and ground, although fewer are found. One of the arguments in this topic with the three elements of Toulmin's argument was the 8th discourse (Figure 4). The 8th discourse described the potential of the standard electrode, where the claim contained information about measuring the potential of the electrode, the ground contained information about the cause of the potential difference between the anode and the cathode, and the warrant contained information about the electrode potential owned by each electrode. In this topic, it was found that the warrant was written in the form of a liaison statement, stating the reason for the claim and certain rules.

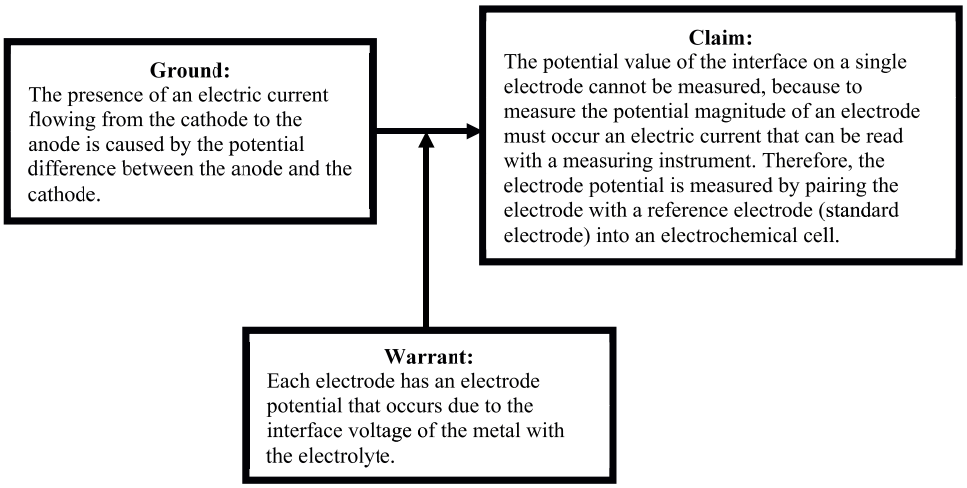

Figure 4: The 8th discourse on standard electrode potential.

The next argument pattern was the four-element argument pattern. In the redox reaction and electrochemistry topic, there were four variations of the pattern, such as GCWB, CGWB, GWCB, and CGWR. Although there were four variations in patterns, the four-element Toulmin's argument pattern had very few arguments, with the GCWB and CGWB patterns each having only two arguments, while the GWCB and CGWR patterns had only one argument each. From the four patterns, it could be found that most of the backing was in the last position of the argument explaining the warrant that was in

the previous position. There was one pattern that did not use the baking element, but rather the rebuttal element. One of the arguments with a four-element argument pattern was the 10th discourse (Figure 5). The 10th discourse described the measurement of the potential of the standard electrode. The claim contained the definition of the potential of standard electrodes. The ground contained an image of a Voltaic cell. The warrant described how to determine the size of the electrode potential. While the backing contained information about the half reaction of the standard electrode potential, along with the notation of the half cell, to support the warrant.

The quality of the argument elements in the redox reaction and electrochemistry topic in the book varied from medium to high according to TAP parameters (Figure 6) and was fair to excellent based on the QASR parameters (Figure 7). Claim and ground elements were mostly classified as having the highest quality of the two parameters. Judging from the results of the analysis, most of the elements were already excellent, which meant students easily understood the intent of these elements and the words conveyed were more communicative. Meanwhile, the rebuttal was relatively good because it required additional explanation to complete the rebuttal.

Based on the results of the analysis of the quality of the argument elements, the arguments that are not appropriate can be identified quickly. Improper arguments could be seen from ground and warrant elements whose quality levels are good, fair, and poor based on QASR parameters. The first discourse of this topic was to explain the equalization of redox reactions. In the ground of the discourse, it was explained that an equation of chemical reactions contained laws such as the law of mass conservation and the law of charge conservation. The ground was not complete enough to support the whole argument because there was no definition of both laws. This also applied to the 6th discourse, regarding the explanation of the salt bridge (Figure 3). Ground described the mechanism of neutralization of ions by the salt bridge but did not go into detail about the salt bridge's shape. This will certainly make it difficult for students to understand the physical form of the salt bridge.

In addition, in the 11th discourse on the potential value of standard electrodes, the ground explained the standard electrode potential values of some electrodes, which were presented in table form. In the table, there were two columns, namely the half reaction and the value of E^o. Although many half-cell reactions are mentioned in the table, there are things that need to be clarified, such as the presence of half-cell reactions without involving metals. There are many types of electrodes used on Voltaic cells, but students are only introduced to hydrogen electrodes and metal electrodes. To

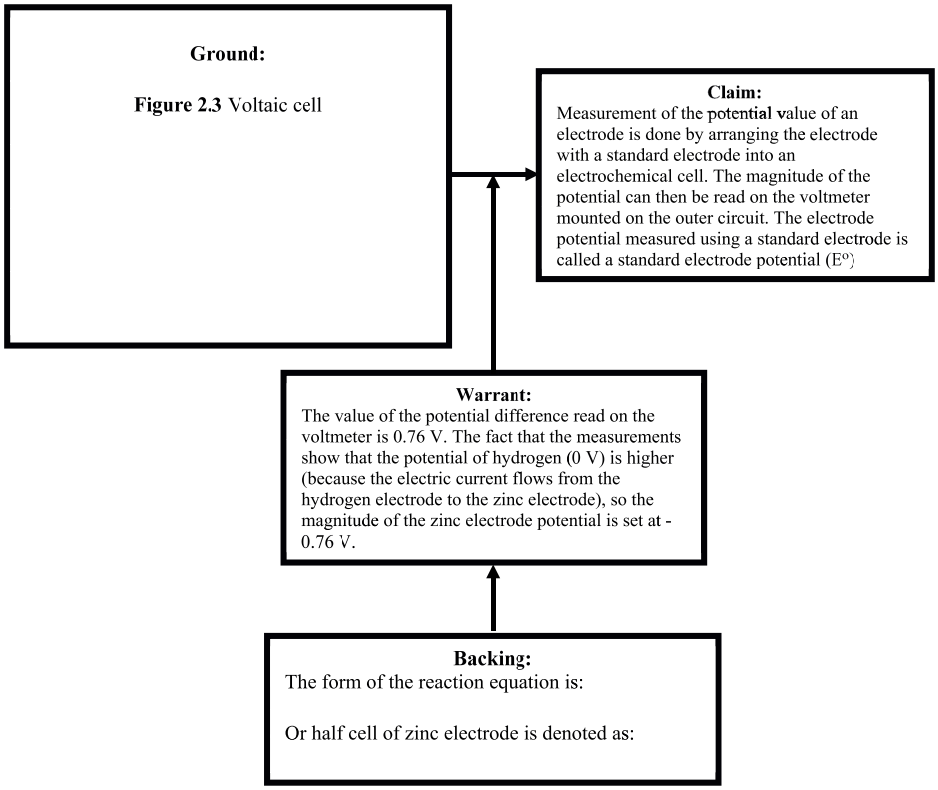

Figure 5: The 10th discourse on standard electrode potential.

clarify this, the authors of the book should add an explanation of the types of electrodes that can be used in Voltaic cells.

In the grounds of the 24th to 26th discourse, there was a deficiency in its explanation for strengthening the claim (Figure 7). The essence of the 24th discourse was that water and air humidity became one of the factors that accelerate corrosion. In the ground, it was not explained why moist air could speed up the corrosion process. The author of the book could add its chemical reactions and their relationship to the rate of corrosion reactions if the amount of water was greater. This type of electrolyte also included factors that accelerated corrosion, which was described in the 25th discourse. The ground discourse explained that electrolytes were composed of acids or salts. This needed to be clarified again, because the base was also classified as an electrolyte. Perhaps the authors of the book wanted to make it clear that rainwater (acid) and seawater (salt) were the main causes of corrosion, so did not include bases as examples of electrolytes as well. To avoid misunderstandings, it should also be written as a base as one of the electrolytes. In addition, in the 26th discourse, it contained an explanation of the formation of electrochemical cells. Students have already obtained an explanation that electrochemical cells consisted of Voltaic cells and electrolysis cells. As a result,

the explanation at the heart of the 26th discourse appeared hazy because it did not specify what type of electrochemical cell was taking place. The following texts are the ground found in the 24th, 25th, and 26th discourse.

1. Claim of the 24th discourse

   Moist air that contains a lot of water vapor will speed up the corrosion process.

2. Claim of the 25th discourse

   Electrolytes (acids or bases) are a good medium for charge transfer.

3. Claim of the 26th discourse

   If two different metals have the potential to intersect in a watery or humid environment, electrochemical cells can form directly.

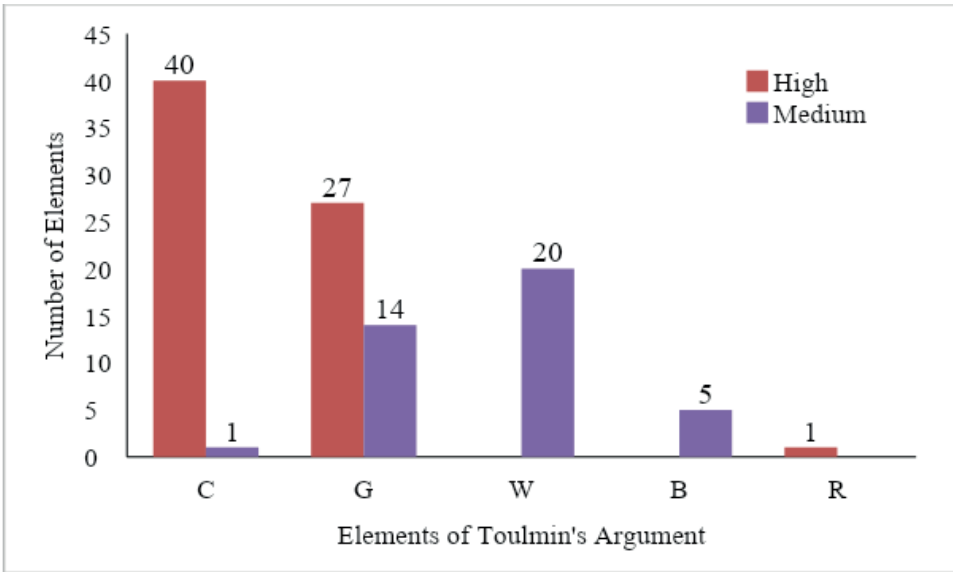

Figure 6: The quality of the argument element is based on the TAP parameters.

Meanwhile, in the 33rd discourse, it contained the first Faraday's law. On the ground, it contained an example of a reaction at the cathode of an electrolysis cell, namely $L^{n+}(aq) + e^{-} \longrightarrow L(s)$. Although this reaction was already quite correct, the writing of chemical reactions in the book should follow the equivalent reaction equation, namely $L^{n+}(aq) + ne^{-} \longrightarrow L(s)$. This may be overlooked in other chemistry books when writing down reaction equations, but these reaction equations can help students understand equal reaction equations and train students to to equalize reactions before solving problems.

All the grounds that have been described had a good quality, but there was one ground that had a fair quality, namely the 38th discourse. The 38th discourse was about

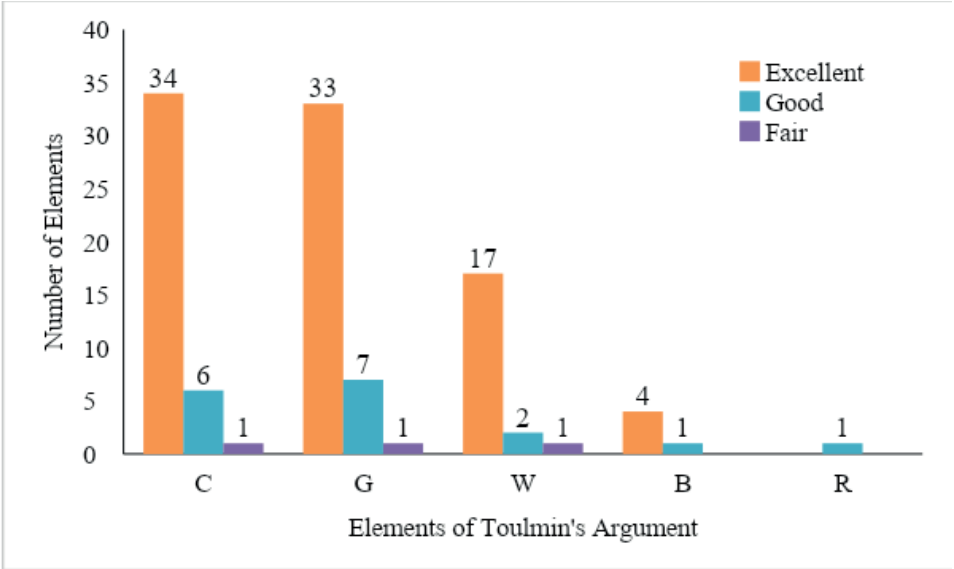

Figure 7: The quality of the argument element is based on the QASR parameters.

one of the usage of electrolytic cells in industry, namely copper purification. The contents of the claim were ways of purifying copper, namely by electrolysis of $CuSO_4$ solution. Anode was an impure copper metal, while cathode was pure copper. Meanwhile, the contents of the ground where the process of taking copper from copper ore was done by reduction, then obtaining copper that was not yet pure. Statements on the ground were less supportive of claims and need to be accompanied by a lot of explanation. The most important explanations to add to the ground were the chemical reactions that occurred at the time of $CuSO_4$ electrolysis and how copper reduction was processed from copper ores. The same was true for the previous discourse, the 37th discourse, i.e., the need for added chemical reactions to explain the Hall-Heroult process.

In addition to the ground, warrant elements also need to be considered to identify the wrong arguments. In the second discourse, there was a discourse on some equal reaction equations, and all of them were theoretically correct. It was considered theoretically correct because it obeyed both the law of mass conservation and the law of charge conservation. In the ground, chemical reactions could occur between the permanganate ions and hydrogen peroxide, namely as follows.

1. $2MnO_4^-(aq) + H_2O_2(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 2O_2(g) + 4H_2O(l)$
2. $2MnO_4^-(aq) + 3H_2O_2(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 4O_2(g) + 6H_2O(l)$
3. $2MnO_4^-(aq) + 5H_2O_2(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 5O_2(g) + 8H_2O(l)$
4. $2MnO_4^-(aq) + 7H_2O_2(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 6O_2(g) + 10H_2O(l)$

In the ground, it was explained that an experiment could be done to find out which reaction was the most correct. If each mole of MnO_4^- produced 5 moles of oxygen, then equation (c) was most correct because it corresponded to the facts of the experiment. However, this statement was false because, based on equation (c), 2 moles of MnO_4^- produced 5 moles of oxygen, not from each mole of MnO_4^-. The author of the book should be careful in providing explanations for each discourse in the book so as explanation does not cause misunderstanding by students.

Furthermore, the 25th discourse also had things that need to be clarified in the warrant section. As explained earlier, the 25th discourse described electrolytes as factors that accelerated corrosion. Warrants containing electrolytes were able to accelerate the binding of electrons by air, so corrosion was faster to form. In addition, rainwater was known to contain a lot of acid, while seawater was known to contain a lot of salt. To clarify and improve students' understanding, the authors of the book should add examples of acidic compounds and salts present in rainwater and seawater.

In addition to the ground and warrant, it was found that there was an incorrect explanation or less in the claims section. As examples of batteries, the 17th and 18th discourses mentioned alkaline cells and silver oxide cells. Both types of batteries used KOH paste as their electrolyte. In the ground, it was explained that the reaction occurs in both batteries, but there was no reaction involving KOH. Although the reaction to the anode was written that zinc metal reacts with OH-, there was no explicit explanation of KOH's function of providing an acidic atmosphere for the anode, which will then produce hydroxide ions and a reaction will occur. This KOH function should be clearly written in the claims section. Meanwhile, the 20th discourse was also still discussing batteries, namely Ni-Cd cells. Based on the explanation in the claim section, the paste used was a Ni_2O_3 compound, but the reaction to the cathode that occurred involves NiO_2. The difference in compounds between those described in paragraphs and those described in chemical reactions will make it difficult for students to determine the correct compounds. This reaction needs to be corrected, whether it was wrong to write the compound or both are true but under different conditions. Furthermore, the 21st discourse that described lithium batteries had shortcomings in explaining the type of organic solvent used to dissolve $LiPF_6$ and the reason for using a solution concentration of 1 M.

Most of the lack of arguments found was due to the lack of complete data or explanations to support the claim. However, there was also an incorrect claim, or the truth was questioned, namely the 27th discourse. At the heart of the 27th discourse were ways that can be done to slow corrosion. One of them was to control the atmosphere

so that it was not moist and did not have much oxygen by flowing CO_2 gas. CO_2 gas was known to react with rainwater to form acid rain, so draining CO_2 gas was supposed to accelerate corrosion [52]. For that, in order not to cause confusion, the author of the book needs to add a reason why CO_2 gas can reduce oxygen levels and make the atmosphere not moist.

In general, based on the types of Toulmin's argument patterns found, there are still few patterns of Toulmin arguments that have a complete argument element. Toulmin's three main elements are actually enough to form an argument, and the argument is acceptable. However, that doesn't mean the supporting elements can be ignored. Supporting elements have a significant role to play in strengthening arguments. The argument will be stronger if the elements of Toulmin's argument are more complete [40]. There are also other studies that reveal that backing is also classified as the main element, so it is only when there are four elements (claim, ground, warrant, and backing) that the argument can be said to be of high quality [30, 35, 53]. Toulmin also admits that the supporting elements are not much to be found in written arguments [35].

The dominating two-element argument pattern proves that warrants are often overlooked in the writing of arguments. If there are only two elements, the argument is not strong because only the ground is able to strengthen the claim [53]. There is an assumption that the ground alone is sufficient to support the claim, so many works of writing do not write warrants [54]. Another cause, namely, warrants, can be delivered implicitly so that analysts cannot identify the existence of claims [35]. This implicit delivery aims to make the warrant easily distinguished from the ground, because the ground is conveyed explicitly and contains more specific information [35]. The pattern of arguments dominated by the pattern of basic arguments shows that in the redox reaction and electrochemistry topic, there have not been many strong or adequate arguments.

This research is limited to examining three aspects, namely the Toulmin's argument patterns, their elements, and fallacies that exist on the topic. In addition, because researchers only involve two chemistry teachers to participate in researching, the pattern of arguments obtained is limited to the analytical ability of three people. It does not rule out the possibility that it will get different results if analyzed by more researchers or analyzed by different researchers.

4. CONCLUSION

Based on the results and discussion, then in the book that was analyzed on the redox reaction and electrochemistry topic, there is a pattern of Toulmin arguments, namely the pattern of Toulmin arguments of two elements, three elements, and four elements, as much as 51%, 34%, and 6%, respectively. The two-element argument patterns consist of CG and GC patterns. The three-element argument patterns consist of the CGW, GWC, CWG, WCG, and GCW patterns. The four-element argument patterns consist of GCWB, CGWB, GWCB, and CGWR patterns. The quality of the argument elements according to the TAP parameter varies between medium and high, while according to the QASR parameters, it varies from fair to excellent. In the redox reaction and electrochemistry topic, there are five claims, eight grounds, and two warrants that are not precise or incomplete.

The results of this study can be used as a reference in researching various textbooks, student texts, and scientific articles related to Toulmin's argument patterns. With a lot of research related to Toulmin's argument patterns and fallacies or lack of arguments, it can help many book authors or article authors in conveying their arguments even better. In addition, if it is obtained from the results that many basic argument patterns in the writing work, then it can be continued by developing a book based on Toulmin's model.

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